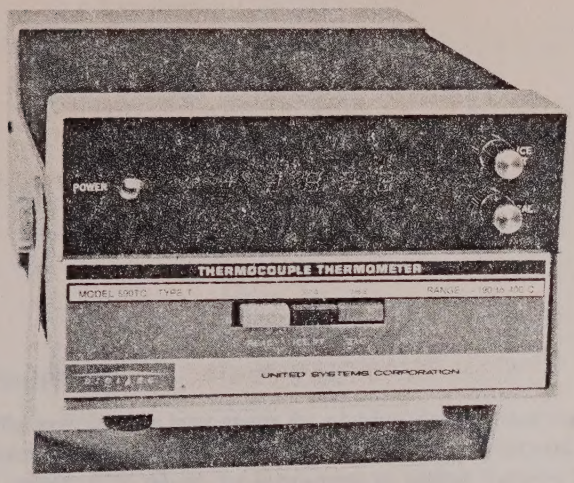
model 590 digital thermocouple thermometer



instruction manual
mi-1387 B

METER ROOM
MODEL 590

MP MASTER
MA26227

DIGI/EC instrumentation

UNPACKING AND SHIPPING

After unpacking, carefully examine the instrument for physical damage that may have occurred in transit. If any damage is noted, immediately contact United Systems Corporation for further instructions.

If it should become necessary to return the instrument to United Systems Corporation, make certain that at least four inches of padding material surrounds the instrument to prevent damage during shipment. When returning instruments to the factory, give a full description of the failure of the instrument and the mode of operation that was used when the instrument failure occurred. Ship via REA Express, motor truck, or air freight PREPAID to:

United Systems Corporation
918 Woodley Road
Dayton, Ohio 45403

For foreign countries: Please contact your local representative for instructions.

WARRANTY

UNITED SYSTEMS CORPORATION warranties that each instrument and other articles of equipment manufactured by USC to be free from defects in material and workmanship, when subjected to normal use and service. This warranty is expressly limited to the servicing and/or adjusting of USC supplied equipment (i. e. USC is not liable for damage to customer supplied equipment interfaced with USC equipment) returned, freight prepaid, to the factory or to the nearest factory authorized service center within one year from date of delivery; and to the repairing, replacing or adjusting of parts (excepting lamps, fuses, batteries, probes and electro-mechanical assemblies) which upon examination shall be found defective. This warranty shall not apply to any instrument or other article of equipment which has been repaired or altered outside of USC factory or authorized service stations nor which has been subject to misuse, negligence or accident, incorrect wiring by others, or installation of use not in accord with instructions furnished by the manufacturer.

Material on electro-mechanical assemblies is warranted for 1 year from the date of delivery while labor is warranted for 90 days from the same date.

This warranty is expressly in lieu of all other warranties expressed or implied and of all other obligations or liabilities on its part, and UNITED SYSTEMS CORPORATION neither assumes nor authorizes any other persons to assume for it any other liability in connection with the sale of its products beyond the specifically provided hereinabove.

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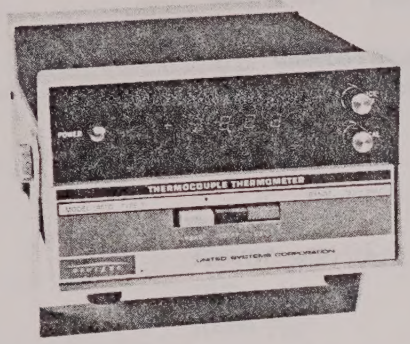
DIGITAL THERMOCOUPLE THERMOMETER



1. GENERAL INFORMATION

The 590 Series of thermocouple thermometers are designed to be used with five of the most popular thermocouples in use today. These thermometers cover the complete ISA temperature spectrum in either degrees Fahrenheit or degrees Celsius. Linearization is accomplished by using a unique digital technique utilizing 32 discrete break points.

Other unique features include:

Digital display blanking if thermocouple should open.
Provisions for external ice point compensation.
Extremely long life LED display.

1.1 Instrument Identification

The instrument model number, serial number, fuse size, and power requirement are given on the identification tag on the rear of the instrument.

1.2 Technical Characteristics

	Degrees Centigrade				
Model Number	590 JC	590 KC	590 RC	590 SC	590 TC
ISA TC Type	J	K	R	S	T
TC Material	Iron-Constantan	Chromel-Alumel	Platinum-Platinum 13%Rh	Platinum-Platinum 10%Rh	Copper-Constantan
Range	-190° to -160.0°C	0° to 1400.0°C	50° to 1600°C	500 to 1600°C	-190° to 400.0°C
Repeatability and Resolution	.1°C	.1°C	1°C	1°C	.1°C
Linerization Conformity	0.5°C	1°C	0.5°C	0.5°C	0.5°C
ICE Point Stability (can be nulled out)	.042°C/°C	.045°C/°C	.40°C/°C	.40°C/°C	.045°C/°C
Digitizing Error (can be nulled out)	.02% of Reading ±1 Digit	.02% of Reading ±1 Digit	.02% of Reading ±1 Digit	.02% of Reading ±1 Digit	.02% of Reading ±1 Digit
	Degrees Fahrenheit				
Model Number	590 JF	590 KF	590 RF	590 SF	590 TF
ISA TC Type	J	K	R	S	T
TC Material	Iron-Constantan	Chromel-Alumel	Platinum-Platinum 13%Rh	Platinum-Platinum 10%Rh	Copper-Constantan
Range	-320.0° to 1400.0°F	-310° to 2500°F	200° to 3200°F	200° to 3200°F	-313 to 752.0°F
Repeatability and Resolution	0.1°F	1°F	1°F	1°F	0.1°F
Linearization Conformity	1°F	1°F	1°F	1°F	1°F
ICE Point Stability (can be nulled out)	.052°F/°F	.33°F/°F	.48°F/°F	.48°F/°F	.057°F/°F
Digitizing Error (can be nulled out)	.02% of Reading ±1 Digit	.02% of Reading ±1 Digit	.02% of Reading ±1 Digit	.02% of Reading ±1 Digit	.02% of Reading ±1 Digit

Rejection	**Normal Mode** 70dB @ 30Hz 80dB @ 60Hz **Common Mode** 140dB @ DC 120dB @ 60Hz
Ice Point	
Conformity –	All °C Models: 0.3°C
(0° – 50°C Ambient)	All °F Models: 0.5°F
Input Bias Current	2 nA Typ.
Overload Protection	±20VDC or 20 VAC
Sampling Rate	10/Sec., Nominal
Response Time	700ms Typ.
Response Time for Open TC	300ms. max.
Operating Ambient	0 to 50°C
Warm-up Time	20 min.
Power Requirements	115/220VAC @ 50-400Hz, 20VA
Isolation	
Guard to Ground	250VDC
Input Low to Guard	100VDC
(without damage see CM Spec.)	
Input Low to BCD Ground	200VDC

SYSTEM INTERFACE

Inputs

Buffer Inhibit — The reading and BCD output may be inhibited from updating while allowing all other functions to continue. This can be accomplished by connecting a jumper from Pin F (inhibit) to Pin 6 (common) on the rear connector or by applying logic "0" to Pin F.

Logic
"1" — +2.0V minimum to +5.5V maximum or open circuit
"0" — +0.8V maximum @ 1.4mA sink, typical

Sample Inhibit/External Interrogate — Sampling may be inhibited while retaining the previous reading indefinitely by applying a logic "0" to the external interrogate input (Pin D) of the rear connector. With a positive pulse (logic "1") applied to this input for 10 microseconds to 40 milliseconds a single sample will be produced while updating the display and BCD output. Updating will occur within 60 milliseconds following the leading edge of the interrogation pulse.

Logic
"1" — +2.0V minimum to +5.5V maximum or open circuit
"0" — +0.8V maximum @ 1.4mA sink, typical

Outputs

System Ready — Pulse of +2.2V minimum into 1KΩ load for 0.1 microsecond indicates data has been stored and is available at the BCD output.

BCD (including error)
Logic is isolated from guard.
Maximum of 1700 volts

Logic
"1" — +2.2V minimum into 1KΩ load
"0" — +0.5V maximum @ 1mA sink

Error bit becomes a logic "1" when display blanks

2. OPERATION

2.1 Precautions

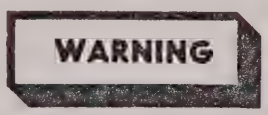
These thermometers are shipped with a small blue plug inserted in the rear of the unit. This plug MUST be used. FAILURE TO EMPLOY THIS PLUG WILL PRODUCE A LARGE ERROR IN THE DIGITAL READING.

The digital display will indicate temperatures in excess of the maximum range of the instrument; however, readings which exceed the range will not be correct.

An open probe will blank the display indicating an error.

The temperature reading is an algebraic summation of the probe accuracy and the instrument accuracy. In many cases, the probe accuracy may greatly exceed the instrument accuracy. See Section 3.5 for typical probe and extension wire accuracy.

These instruments must be used with a 3-prong U-grounded receptacle outlet. Failure to use a grounded outlet may result in improper operation or safety hazard.



A power conversion switch is located on the rear panel. Do not operate the instrument on 230 volts with the switch set to 115 volts.

2.2 Turn On Procedure

Turn the instrument "ON" with the POWER switch and allow 20 minutes warm-up. The instrument will operate immediately. However, a 20 minutes warm-up is required for specified accuracy.

After warm-up depress the ICE POINT button and adjust the ICE POINT control for the reading specified on the front panel.

Then depress the CAL button and adjust the CAL control for the reading specified on the front panel.

3. INSTALLATION

3.1 Precautions

When installing in a cabinet, allow sufficient space around the unit for circulation of air. Do not exceed an ambient temperature of 50°C.

Connect to a "clean" 3-wire power line of the correct voltage and frequency. Locate the instrument in a clean dry area with the proper ambient temperature limits.

3.2 Input Connections

There are three input posts on the rear of the instrument in addition to a nine-pin plug. The input posts are marked positive, negative, and guard. Normally, the red thermocouple wire is tied to the black input post; however, there may be exceptions to this rule. The guard post is normally connected to the shield when using shielded probes. The table below indicates the various types of thermocouples, the recommended color code and polarity.

TYPE	MATERIAL	COLOR	POLARITY
J	Iron	White	+
	Constantan	Red	-
K	Chromel	Yellow	+
	Alumel	Red	-
R	Platinum/13% Rhodium	Black	+
	Platinum	Red	-
S	Platinum/10% Rhodium	Black	+
	Platinum	Red	-
T	Copper	Blue	+
	Constantan	Red	-

The nine-pin plug is used for external ice point compensation (see Section 3.4)

3.2.1 Guarding

The guard terminal should NEVER be left open. In most applications, the guard terminal should be tied to the negative (black) terminal. If long lead resistances are encountered, the guard should be tied to the negative lead at the source rather than at the instrument.

If operating in an extremely noisy environment, extension wires should be shielded with the guard terminal tied to the shield. The shield should then be tied to the negative lead at the source. Do not terminate the shield at more than one point.

3.2.2 Interfacing Connections

There are two different connectors on this instrument. The 30 pin printed circuit strip (J1) is used for system interfacing whereas the 9 pin auxiliary plug (J2) is used for external ice point compensation. The table below lists the pins on the contact strip and their respective function. For output levels, refer to Section 1.2.

INTERFACING CONNECTOR (J1)

Pin	*Function*	*Pin*	*Function*
1	Decimal Point 000.0	A	Not connected
2	Decimal Point 00.00	B	Not connected
3	Decimal Point 0.000	C	Error
4	Decimal Point .0000	D	Sample Inhibit/
5	+5VDC		External
6	Common		Interrogate
7	Polarity	E	System ready

8	BCD 1000	F	Buffer inhibit
9	BCD 2000	H	BCD 10,000
10	BCD 4000	J	BCD 1
11	BCD 8000	K	BCD 2
12	BCD 100	L	BCD 4
13	BCD 200	M	BCD 8
14	BCD 400	N	BCD 10
15	BCD 800	P	BCD 20
		R	BCD 40
		S	BCD 80

This instrument is shipped without a mating connector. To use a mating connector, remove the protective plastic cover from the printed circuit contact strip.

A connector may be purchased from Cinch Jones Corporation or from the factory.

Cinch Jones Part Number 50-30A-30
United Systems Part Number 51-07548-15

AUXILIARY CONNECTOR (J2)

Pin	*Function*
A	Thermistor (brown lead)
B	Thermistor sense to brown lead
C	Thermistor (red lead)
D	Thermistor sense to red lead
E	Thermistor sense to green wire
F	Calibration voltage
G	Not connected
H	Analog Ground
J*	Amplified Thermocouple

*Voltage minus ice point compensation. Non-linearized output voltage is approximately equal to 100 times the thermocouple input @ 1mA maximum.

3.3 Multiple Input Selection

These thermometers are designed to accept only one thermocouple probe; however, there are applications where averaging of more than one thermocouple is required. Thermocouples of the same type may be connected in parallel to produce an average temperature reading.

When it is necessary to sample more than one temperature, the DigiTec Model 638 or 639 multiple input selector or the Model 636/637 Scanner may be used.

3.3.1 Model 638 and 639 Multi-Point Selector

The Model 639 provides for 16 point, two pole switching and is used to manually select any low level voltage. The Model 638 serves the same function, but providing 32 points.

3.3.2 Model 636/637 Scanner

The Model 636 Scanner and 637 Scanner Slave allow up to 1000 points to automatically scan while providing scan point identification. The Model 635-3 Reed Relay Card is designed specifically for use with thermocouples.

3.4 External Ice Point Compensation

When copper input terminals are connected to dissimilar metals, additional thermocouple voltages (other than the probe) will be produced. These voltages must be compensated or an error in temperature will result.

If the temperature of the copper dissimilar metal junction is known, the error introduced by this junction may be compensated electronically, with a thermistor bead, within the thermometer rather than requiring an ice bath of constant temperature.

Many applications require that long extension wires be used with thermocouple probes. Since thermocouple extension wire is more expensive than copper wire, it may be desirable to use copper wires in lieu of extension wire. The thermistor bead may then be externally mounted to allow ice point compensation at a distant location.

The thermister bead must then be externally mounted to allow ice point compensation at a distant location.

This bead may be purchased from a local Yellow Springs Distributor or directly from United Systems Corporation. See Section 8 for ordering information.

Yellow Springs Instrument Part Number 44018
United Systems Part Number 40-12455

Mount the bead to the copper/dissimilar junction box so that the junction box temperature will be as close to the bead temperature as possible. Avoid drafts on the thermistor bead.

To use as external thermistor bead, the internal bead must be electrically replaced with the external bead. To disconnect the internal thermistor, remove the jumpers from Pins A & B, and C & D of the auxiliary connector. Connect the external thermistor as shown below.

Brown wire to Pin B
Red wire to Pin D
Green wire to Pin E

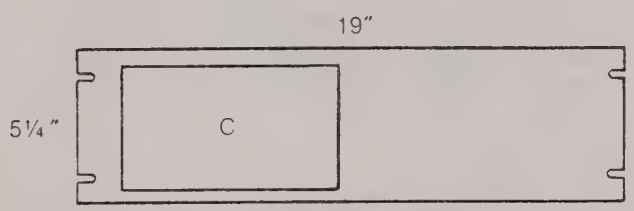
3.5 Probe and Extension Wire Accuracy

Thermocouples are made in a wide variety of materials and purities. The table on the following page lists the thermocouples used in the 590 Series of Thermometers along the typical applications and accuracies.

Thermocouple		Advantages	Disadvantages	Notes	Typical Limits of Error		
Type	Material				Range (°F)	Standard	Special
J	Iron-Constantan	Most widely used. Low cost.	Iron often attacked in atmospheres of ammonia and hydrogen.	Used in both oxidizing & reducing atmospheres	0 to 530	±4°F	±2°F
					530 to 1400	±3/4%	±3/8%
K	Chromel-Alumel	Relatively high accuracy	Do not use in a reducing condition. Partial oxidizing condition causes "green rot"	Oxidizing atmosphere recommended	0 to 520	±4°F	±2°F
					530 to 2300	±3/4%	±3/8%
R	Platinum-Platinum/ 13% RH	Higher output than type "S"	High cost. Gradually decreasing EMF above 1400°C	Industrial Applications	0 to 1200	±5°F	±2-1/2°F
					1200 to 2700	±1/2%	±1/4%
S	Platinum-Platinum/ 10% RH	International standard for temperatures from 630.5° to 1063°C	High cost. Gradually decreasing EMF above 1400°C.	Two types: 99.99% pure-standard 99.999% pure lab reference	0 to 100°	±5°F	±2-1/2°F
					1000 to 2700	±1/2%	±1/4%
T	Copper Constantan	Rust and Corrosion resistant	Cannot be used with alkaline solutions	Fine for low temperature	-75 to 200	±1-1/2°F	±3/4°F
					200 to 700	±3/4%	±3/8%

3.6 Rack Mounting

There are three panel adaptor kits used to mount this instrument into a standard 19 inch rack cabinet. The Model 727 L/R kit is used to mount one instrument into a 5¼" high space. The Model 724 kit is used to mount two instruments into a 5¼" high space. The Model 729 kit is used to mount one voltmeter along with a Model 691 Printer into a 7" high space.



Model 727 L/R Panel Adaptor Kit
Figure 1

3.7 Unattended System Operation

When using these instruments in unattended systems, it may be desirable to check for long term calibration and ice point drift. Calibration may be checked by connecting the calibration voltage (J2, Pin F) to the positive input terminal and simualting the ice point thermistor at 0°C.

Ice point may be checked by shorting the input while simulating the resistance of the ice point thermistor at 0°C.

To simulate the ice point compensation thermistor at 0°C, remove the two jumpers in the auxiliary connector (J2) and add a 19.59K 0.1% resistor between Pins B and E and a 94.98K 0.1% resistor between Pins D and E.

4. SYSTEM ACCURACY

The system accuracy of a thermometer is total accuracy of all factors that could produce an error. These factors include the total instrument accuracy plus the probe and extension wire errors.

The total instrument accuracy is composed of ice point accuracy, conformity, and analog to digital conversion (A to D) accuracy. The total accuracy may be expressed in two ways:

(1) Worst Case = Ice point accuracy+conformity +A to D conversion accuracy

(2) Typical Error = $\sqrt{(\text{Ice point accuracy})^2+(\text{conformity})^2+(\text{A to D conversion accuracy})^2}$

Worst case error is rarely found, if ever, in any thermometer since it is highly unlikely that all variables will have the maximum allowable error with all errors being in the same direction (i.e. all positive

or all negative). A more realistic error figure can be derived by adding the errors vectorially instead of linearly as used to calculate worst case error.

Example: The Model 590JC (iron-constantan) has ice point accuracy of 0.3°C, conformity of 0.5°C, and an A to D conversion accuracy of 0.02% of reading ± 2 digits. For ease of calculation, assume the temperature reading of 500°.

$$\text{Worst Case} = 0.3^\circ+0.5^\circ+0.02\%\ (500)+2 \text{ digits} = 0.3^\circ+0.5^\circ+0.1^\circ+.2^\circ = 1.1^\circ\text{C}$$

$$\text{Typical Error} = \sqrt{(0.3^\circ)^2+(0.5^\circ)^2+(0.3^\circ)^2} =$$

$$\sqrt{.09+.25+.09} = \sqrt{0.43} = 0.66^\circ\text{C}$$

These error calculations are for the instrument only. Any error introduced by the probe and extension wire must be added to the instrument accuracy. These errors will vary since they are produced by impurities in the thermocouple wire. Typical error for type J thermocouples at 500°C is from 1.11 to 2.22°C. Extension wire will also produce an error of 1.11 to 2.22°C. See Section 3.5 for typical probe and extension wire accuracy.

Using standard thermocouple with standard extension, the worst case system accuracy would be:

$$1.1^\circ + 2.22^\circ + 2.22^\circ = 5.54^\circ\text{C}$$

Error due to extension wire resistance will be negligible (less than 1 digit) if the total resistance does not exceed 500 ohms. The chart below indicates resistance per foot at 70°F for various wire sizes.

Material	8	14	16	20
Alumel	.011	.043	.069	.113
Chromel	.026	.104	.165	.415
Constantan	.018	.072	.114	.281
Copper	.0006	.003	.004	.01
Iron	.004	.015	.030	.059

5. GENERAL RULES

THERMOCOUPLE

When purchasing thermocouple wire, it is imperative that the wires be procured in pairs, at the same time, and from the same source. Although correctly paired wires will conform to the ISA tables, randomly paired wires may not.

Avoid locating the thermocouple where it will be in a direct flame. Immerse the thermocouple far enough so that the measuring junction is entirely immersed in the temperature to be measured. Heat that is conducted away from the hot junction will cause an incorrect reading. As a rule of thumb, the immersion depth should be ten times the diameter of the protection tube. Do not use a chromel/alumel (Type K) thermocouple below 1000°F if it is was used above 1600°F. Use thermocouple protection tubes where conditions warrant their use.

If the thermocouple is insulated but installed near high voltage equipment, the thermocouple should be grounded. To do this, connect a wire from the negative lead (black terminal) to ground (silver terminal).

There are two types of wire that may be used when adding extra lead length to thermocouple probes:

(1) Copper wire with an external thermistor at the junction of the copper wire and the thermocouple probe (see Section 3.4).

(2) Thermocouple extension wire. The table below lists the proper type of extension wire to use and the error expected from the wire.

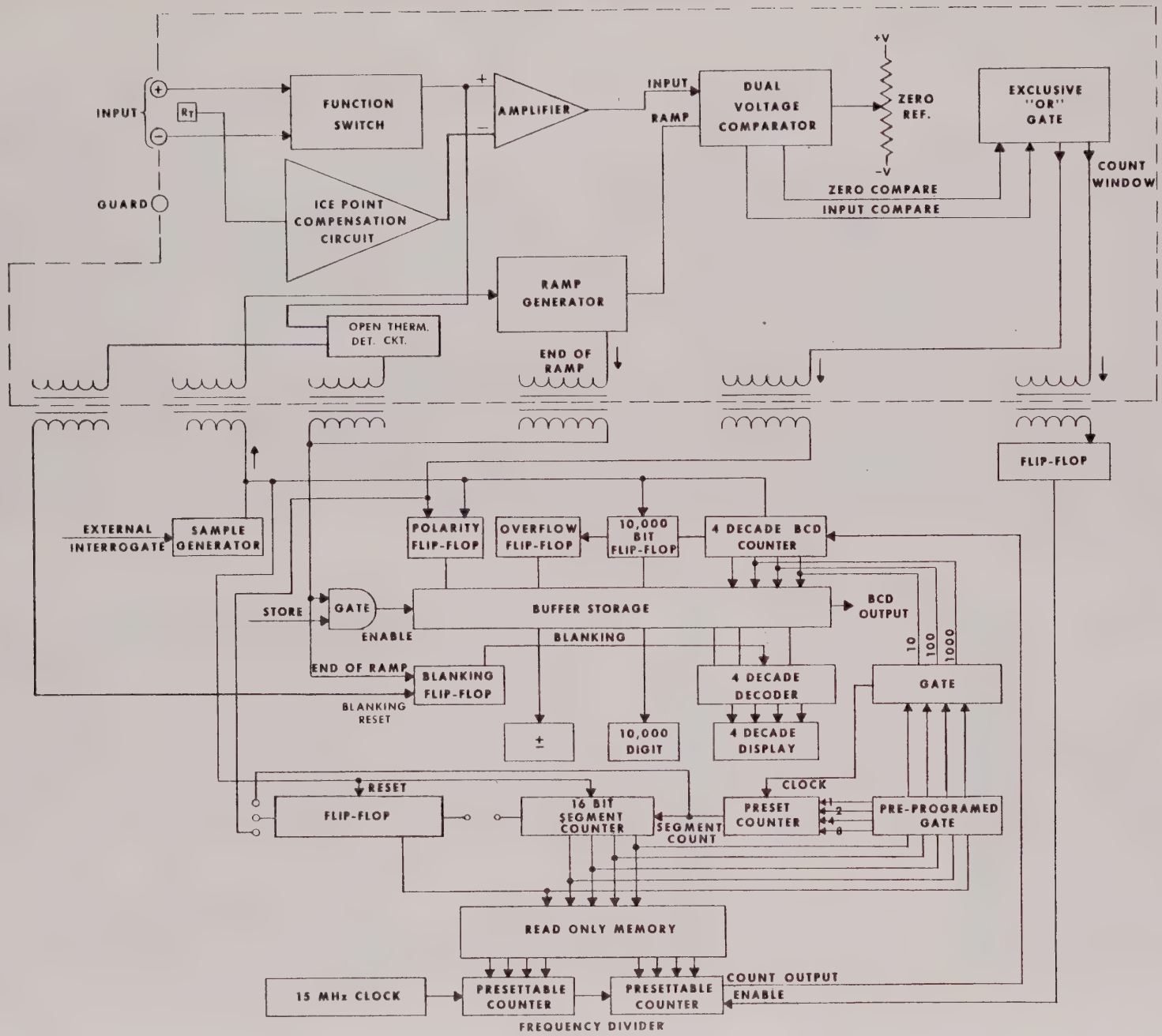
EXTENSION WIRE

When purchasing thermocouple wire, it is imperative that the wires be procured in pairs, at the same time, and from the same source. Although correctly paired wires will conform to the ISA tables, randomly paired wires may not.

If possible, install extension wires in a grounded conduit by themselves. All wires that must be spliced should be soldered.

Type of Thermocouple	Type of Extension Wire	Temperature Range °F	Limits of Error °F	
			Standard	Special
Iron-Constantan (J)	Iron-Constantan	0 to 400	±4	±2
Chromel-Alumel (K)	Chromel-Alumel	0 to 400	±4	–
	Iron-Alloy	75 to 400	±6*	–
	Copper-Constantan	75 to 200	±6*	–
Platinum-Platinum/Rh (R&S)	Copper-Alloy	75 to 400	±12*	–
Copper-Constantan (T)	Copper-Constantan	-75 to +200	±1-1/2	±3/4

*Limits of Error are applicable for a reference junction temperature of 75°F only.



Block Diagram
Figure 2

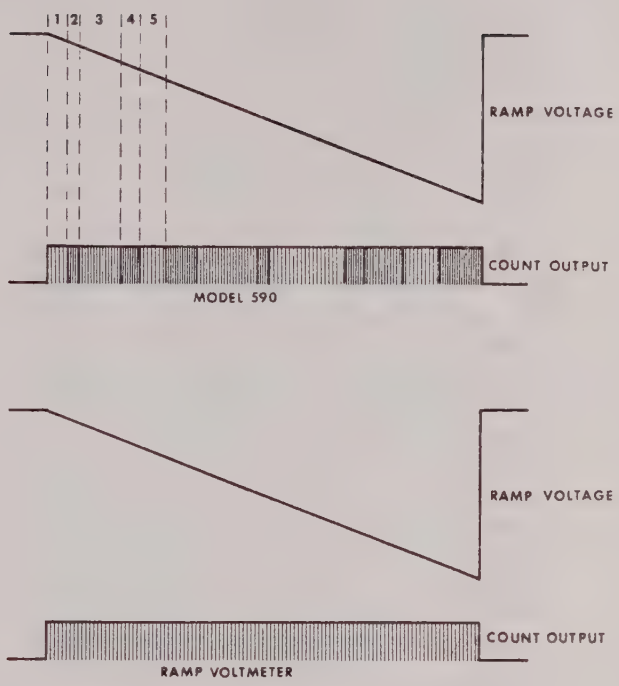
6. CIRCUIT DESCRIPTION (See Figure 2)

The technique used to measure temperature in Model 590 Thermocouple Thermometers is actually an extension of the ramp technique used in many DigiTec voltmeters. Normally the ramp measurement technique operates as follows: The voltage signal to be measured is directed to one input of a dual voltage comparator. A reference voltage indicating the zero level is directed to another input of constant slope is applied to a third input. The circuit then compares these inputs and issues two output signals.

One of the outputs occurs when the ramp voltage equals the zero reference voltage. The second occurs when the ramp voltage equals the voltage of the signal to be measured. Both of these outputs are directed to an exclusive "or" gate, a circuit which has a true output whenever one or the other of its inputs is true, but gives no output when the inputs are identical. Thus the output of this gate goes true when the zero coincidence signal is received, and remains true until the measured voltage coincidence is received (the sequence is reversed if the measured signal has a negative polarity).

The output of the exclusive "or" gate enables a frequency divider to pass a portion of a 15MHz clock signal which comes from an oscillator circuit. The output of the frequency divider then increments a BCD counter. The counter is incremented at a constant rate during the time period between the zero coincidence and the measured signal coincidence. Therefore, the resultant count is a linear function of the voltage difference between the measured signal and the zero side of the comparator. In a standard voltmeter this count is then decoded and displayed as a digital readout. The voltage output of a thermocouple, however, is non-linear with respect to temperature. Since the objective is to indicate temperature and not thermocouple voltage, the thermocouple output must be linearized. The technique which is used is referred to as piecewise linearization. The voltage-temperature wave form of the thermocouple output is approximated by 32 separate line segments of differing slopes.

Thus is order to utilize the ramp technique to measure temperature there are two alternatives: The ramp voltage could be produced with 32 different slopes to match the linearization approximations, or the counter could be incremented at varying rates depending upon which portion of the temperature-voltage curve is being considered. The second method is utilized. The essential difference between the 590 Thermocouple Thermometer and any voltmeter which utilizes the ramp technique is that the frequency divider is programmable and has a variable output. The frequency divider outputs of a ramp voltmeter and a Model 590 are compared in Figure 3.



Ramp Voltmeter and Model 590
Figure 3

The circuitry which implements the measurement process already described is contained on two circuit boards: The signal conditioning board and the analog to digital converter. The analog to digital converter converts the processed voltage signal to a digital display using the ramp measurement technique.

ANALOG TO DIGITAL CONVERTER

Transistors Q1-Q3 and their associated resistors give a high input impedence. IC2 is an amplifier with capacitive feedback which generates the ramp voltage. IC1 and IC3 together form the dual voltage comparator. The ramp signal is applied to the non-inverting input of both op-amps (through Q1 in the case of IC1). The zero reference voltage is applied to the non-inverting input of IC3, and the amplified thermocouple voltage is applied to the non-inverting input of I.C.1 through Q1. I.C.6D-F and I.C.7B-D form the exclusive "or" gate; the signal at Pin 11 of I.C.7 is the count gate, or the enabling signal for the frequency divider.

The measurement cycle proceeds as follows. In the normal state the output of IC.2. is positive, which puts a true signal into Pin 10 of IC7A. When the sample generator issues a pulse through T1, Pin 9 of IC7A also goes high which means the output of the gate goes low. This is inverted twice by I.C.5A & I.C.6A so that a low signal occurs at the anode of D1. This disables Q4 enabling IC1 to act as an integrator and begin generating the negative going ramp voltage.

When the voltage at test point B becomes sufficiently negative, Pin 10 will see a low signal and consequently the output of I.C.7A will go high. I.C.6A will then go low and I.C.5A will go high. This biases Q4 on, effectively shorting C3 in the feedback loop with the 1K resistor R4. This means the ramp voltage stops and testpoint B returns to a positive level. At the same time, when IC6A goes low IC6B goes high. The rising edge of the output of I.C.6.B. is differentiated by C19 and R60, and produces a momentary negative going pulse at the output of IC5B. This pulse is transformed through T2 and becomes the buffer pulse which transfers the data in the BCD counter to the output display.

There is one more function which needs explanation in Figure 6. IC6C detects if the measured voltage coincidence is obtained prior to the zero coincidence, which means that the voltage being measured is negative with respect to the zero level. C21 and R59 differentiate the pulse, and IC5D drives transformer T3. The transformer pulse sets a polarity flip-flop which causes a minus sign to appear in the output display. The sample generator (see Figure 5) is a programmable unijunction oscillator. Each output pulse from the sample generator resets the polarity flip-flop, and the BCD counter.

SIGNAL CONDITIONING BOARD (see Figure 10)

The thermocouple voltage is amplified by IC2 using the non-inverting input. The inverting input is connected to the output of IC1 and is used to compensate for the thermocouple generated at the input terminals (thermocouple wire vs. copper input posts). This temperature is sensed with a dual bead thermistor located on the input terminal mounting plate.

The CAL button, when depressed, substitutes the thermistor sensor with a fixed resistor with a resistance equal to that of the thermistor network at 0°C (32°F). A voltage is also generated to simulate the voltage of the thermocouple voltage at the calibration temperature.

When the ICE POINT button is depressed, the ice point thermistor network is again replaced with a fixed resistor and the input to the amplifier is shorted to ground.

The output of IC2 is then scaled by the gain adjustment R27-29 and directed to the analog to digital converter.

Each buffer pulse is inverted by IC18C which drives transformer T3. The transformer pulse activates a monostable multivibrator or "one-shot" IC21. The one-shot output is buffered by Q2 and current flows through C36 and R60, through the thermocouple to ground. This current produces a voltage across R58 which is sufficient to forward bias Q3. This in turn biases Q4 on. The signal from Q4 is shaped by logic gates in I.C.22 so that it is capable of driving T4.

Each buffer pulse, in addition to transfering the data from the BCD counter to the output LEDs, sets the error flip-flop I.C.12b. If the flip-flop is still set when the next buffer pulse occurs, the output display will be blanked. Normally the pulse across T4 resets I.C.12b before the next buffer pulse occurs. If the thermocouple is open however, no current will flow through R60 and C36 and consequently no voltage will develop across R58. This means Q3 cannot be biased on and hence no error reset pulse will be produced. The error flip-flop will remain set, blanking the display and indicating the open thermocouple.

The 15 MHz clock signal is produced by X1, transistor Q1, and the associated capacitors and resistors. The output of the clock is applied to the frequency divider I.C. 15 & 16. The divider passes a portion of the 15MHz signal when it receives an enabling signal from the flip-flop I.C.18b and d. This flip-flop is set when the count gate signal is received from the exclusive "or" circuit through T1 and reset when the count gate is turned off.

The portion of the clock frequency which I.C. 15 & 16 pass depends upon the signals received from the read only memory I.C.14. The outputs of I.C.14 are in turn dependent upon the outputs I.C.11 & 12a. I.C.14 is a 32 bit memory and I.C.11 is a 16 bit segment counter; I.C.12a is a flip-flop. Together these circuits provide 32 different output combinations corresponding to the 32 segments of the linearization approximation. The gates and memories of I.C.4-10 cause I.C.11 & 12a to change output states in response to the outputs of the BCD counter. The interconnection of this logic varies according to the model of instrment. Anywhere from 6 to 16 jumpers are inserted into the 42 positions shown in Figure According to the requirements of the instrument. The following table shows the jumper positions used in the 10 models of the 590 Thermocouple Thermometer.

Model Number	Circuit Jumpers Locations
590-JC	2, 6, 8, 9, 11, 13, 16, 19, 23, 25, 26, 27, 30, 21, 25, 40
590-JF	2, 5, 7, 9, 20, 22, 24, 28, 29, 32, 34, 38
590-TC	2, 10, 12, 19, 29, 38, 40, 42, R7
590-TF	2, 19, 31, 35, 36, 40, R7
590-KC	3, 4, 19, 36, 37, 40, 41
590-KF	1, 2, 10, 12, 14, 15, 16, 18, 21, 24, 28, 33, 36, 38, 42
590-SC	1, 3, 4, 17, 36, 37, 40, 41, R7
590-SF	1, 3, 4, 17, 36, 38, 39, 42, R7
590-RC	1, 3, 4, 17, 36, 37, 40, 41, R7
590-RF	1, 3, 4, 17, 36, 38, 39, 42, R7

7. CALIBRATION

7.1 Necessary Calibration Equipment

1. Millivolt source with an accuracy of ±0.01%
2. Voltmeter, accuracy of 0.005% or better
3. Copper wires
4. INSULATED screwdriver — DO NOT USE A METAL SCREWDRIVER.

7.2 Calibration Check

All break points on these instruments are determined at the factory by using circuit jumpers and fixed programmed ROM's. Before attempting to adjust the end points and the calibrate voltage, the entire range should be checked. The tables listed below indicate the input voltage and the corresponding temperature. See Section 1.2 for the maximum allowable error.

Iron-Constantan (Type J)			
°C	Millivolts	°F	Millivolts
-190	-7.66	-320	-7.79
-150	-6.50	-250	-6.71
-100	-4.63	-200	-5.76
-50	-2.43	-150	-4.68
0	0.00	-100	-3.49
50	2.58	-50	-2.22
100	5.27	0	-0.89
150	8.00	100	1.94
200	10.78	200	4.91
250	13.56	300	7.94
300	16.33	400	11.03
350	19.09	500	14.12
400	21.85	600	17.18
450	24.61	700	20.26
500	27.39	800	23.32
550	30.22	900	26.40
600	33.11	1000	29.52
650	36.08	1100	32.72
700	39.15	1200	36.01
760	42.96	1300	39.43
		1400	42.96

Chromel-Alumel (Type K)			
°C	Millivolts	°F	Millivolts
0	0.00	-310	-5.60
50	2.02	-250	-4.96
100	4.10	-200	-4.30
150	6.13	-150	-3.52
200	8.13	-100	-2.65
250	10.16	-50	-1.70
300	12.21	0	-0.68
350	14.29	100	1.52
400	16.40	200	3.82
450	18.51	300	6.09
500	20.65	400	8.31
550	22.78	500	10.57
600	24.91	600	12.86
650	27.03	700	15.18
700	29.14	800	17.53
750	31.23	900	19.89
800	33.30	1000	22.26
850	35.34	1100	24.63
900	37.36	1200	26.98
950	39.35	1300	29.32
1000	41.31	1400	31.65
1050	43.25	1500	33.93
1100	45.16	1600	36.19
1150	47.04	1700	38.43
1200	48.89	1800	40.62
1250	50.69	1900	42.78
1300	52.46	2000	44.91
1350	54.20	2100	47.00
1400	55.891	2200	49.05
		2300	51.05
		2400	53.01
		2500	54.92

Platinum/Platinum 13% RH (Type R)			
°C	Millivolts	°F	Millivolts
50	0.298	200	0.596
100	0.645	300	1.030
150	1.039	400	1.504
200	1.465	500	2.012
250	1.918	600	2.547
300	2.395	700	3.103
350	2.890	800	3.677
400	3.399	900	4.264
450	3.923	1000	4.868
500	4.455	1100	5.488
550	5.004	1200	6.125
600	5.563	1300	6.773
650	6.137	1400	7.436
700	6.720	1500	8.116
750	7.315	1600	8.809
800	7.924	1700	9.516
850	8.544	1800	10.237
900	9.175	1900	10.973
950	9.816	2000	11.726
1000	10.471	2100	12.488
1050	11.138	2200	13.255
1100	11.817	2300	14.027
1150	12.503	2400	14.798
1200	13.193	2500	15.568
1250	13.888	2600	16.340
1300	14.582	2700	17.110
1350	15.276	2800	17.875
1400	15.969	2900	18.636
1450	16.663	3000	19.394
1500	17.355	3100	20 150
1550	18 043	3200	20 904
1600	18.727		

Platinum/Platinum 10% RH (Type S)			
°C	Millivolts	°F	Millivolts
50	0.299	200	0.596
100	0.643	300	1.017
150	1.025	400	1.474
200	1.436	500	1.956
250	1.868	600	2.458
300	2.316	700	2.977
350	2.778	800	3.506
400	3.251	900	4.046
450	3.732	1000	4.596
500	4.221	1100	5.156
550	4.718	1200	5.726
600	5.224	1300	6.307
650	5.738	1400	6.897
700	6.260	1500	7.498
750	6.790	1600	8.110
800	7.329	1700	8.732
850	7.876	1800	9.365
900	8.432	1900	10.009
950	8.997	2000	10.662
1000	9.570	2100	11.323
1050	10.152	2200	11.989
1100	10.741	2300	12.657
1150	11.336	2400	13.325
1200	11.935	2500	13.991
1250	12.536	2600	14.656
1300	13.138	2700	15.319
1350	13.738	2800	15.979
1400	14.337	2900	16 637
1450	14.935	3000	17.292
1500	15.530	3100	17 943
1550	16 124	3200	18.590
1600	16.716		

Copper-Constantan (Type T)			
°C	Millivolts	°F	Millivolts
-190	-5.379	-300	-5.284
-170	-5.018	-250	-4.747
-150	-4.603	-200	-4.111
-130	-4.138	-150	-3.380
-110	-3.624	-100	-2.559
-90	-3.062	-50	-1.654
-70	-2.455	0	-0.670
-50	-1.804	50	0.389
-30	-1.112	100	1.517
-10	-0.380	150	2.711
0	0.000	200	3.967
50	2.035	250	5.280
100	4.277	300	6.647
150	6.703	350	8.064
200	9.288	400	9.525
250	12.015	450	11.030
300	14.864	500	12.575
350	17.821	550	14.157
400	20.874	600	15.773
		650	17.421
		700	19.100
		750	20.805

7.3 Calibration Procedure

7.3.1 Zener Current Adjustment

(Perform these steps only when the zener diode is replaced or the controls accidentally adjusted).

1. Remove the top and bottom cover.
2. Connect the positive lead of the voltmeter to Point X and the negative lead to Point Y. Adjust R50 for 3.50 volts.
3. Move the negative lead of the voltmeter to the black input jack and adjust R49 for 10.000 volts.
4. Repeat Steps 2 and 3 until the voltage in Step 2 is between 3.45 and 3.55 volts and the voltage in Step 3 is exactly 10.000 volts.

7.3.2 End Point Adjustment

The preceding zener current adjustment MUST be *checked* before attempting to calibrate the end points.

1. Turn the thermometer "on" and allow 20 minutes warm up.
2. Set the front panel ICE POINT and CAL controls for the center scale.
3. Depress the front panel ICE POINT button and adjust the Ice point control on the Rear panel for a digital display of 000.0°C, or 0.32.0°F. Do *not* adjust the front panel ICE POINT control.
4. Depress the front panel CAL button.
5. Move INT/EXT switch to EXT.
6. With the instrument still in CAL position, apply the proper millivolt source to the input and adjust the GAIN control on the rear panel for the desired digital reading (See the table below).
7. Move the INT/EXT switch back to the INT position.
8. Adjust the CAL control on the Rear panel for the calibration point indicated on the front panel. Do *not* adjust the front panel CAL control.

8. REPLACEMENT PARTS

Replacement parts for the components shown on schematics and component location drawings are listed in alpha-numerical order by reference designator under their respective assemblies.

8.1 Parts Ordering

It is recommended that replacement parts be purchased directly from United Systems Corporation. The minimum charge is $10.00 on all orders. The order should be sent to:

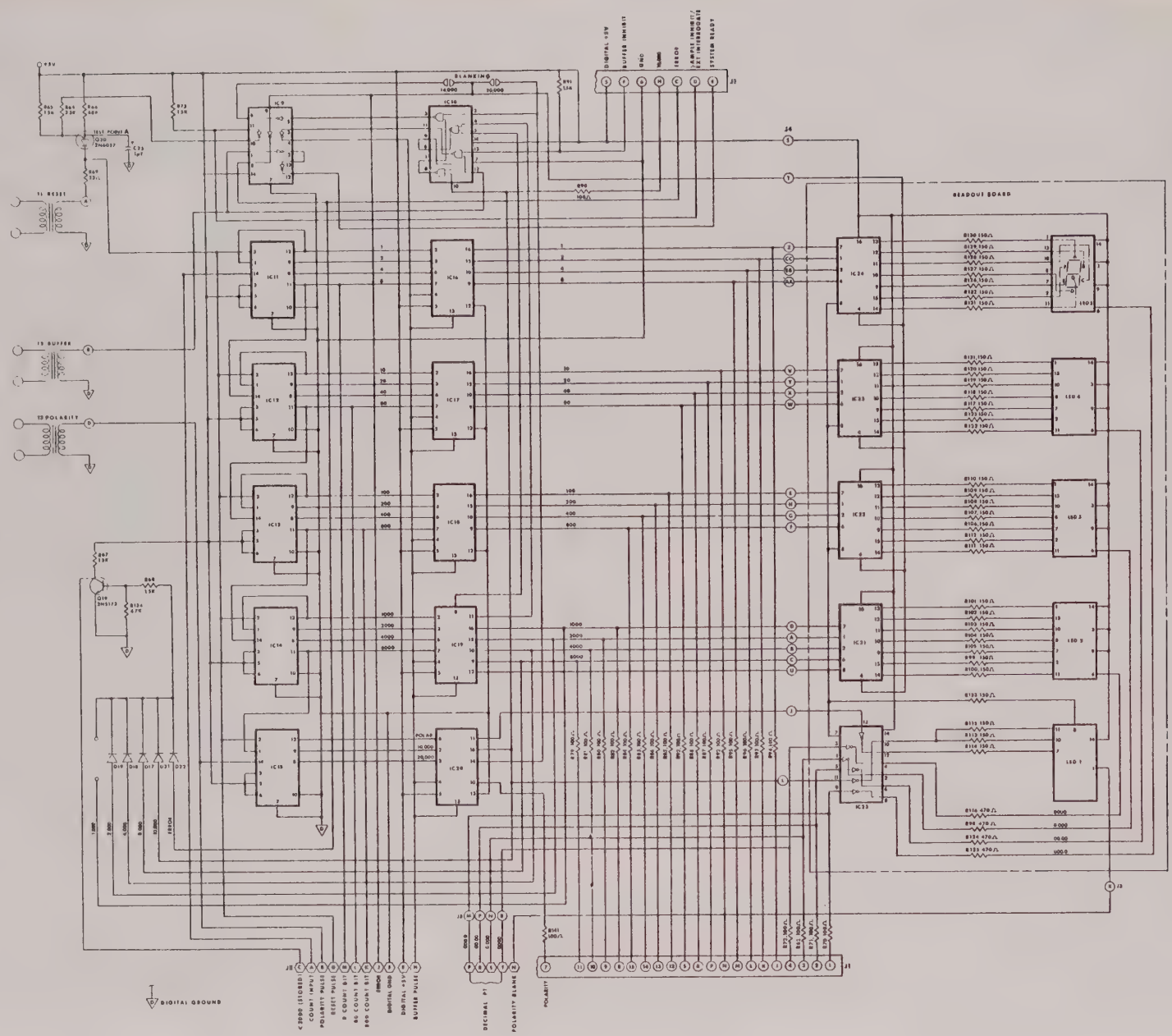
United Systems Corporation
918 Woodley Road
Dayton, Ohio 45403

For each replacement part, the following information should be included:

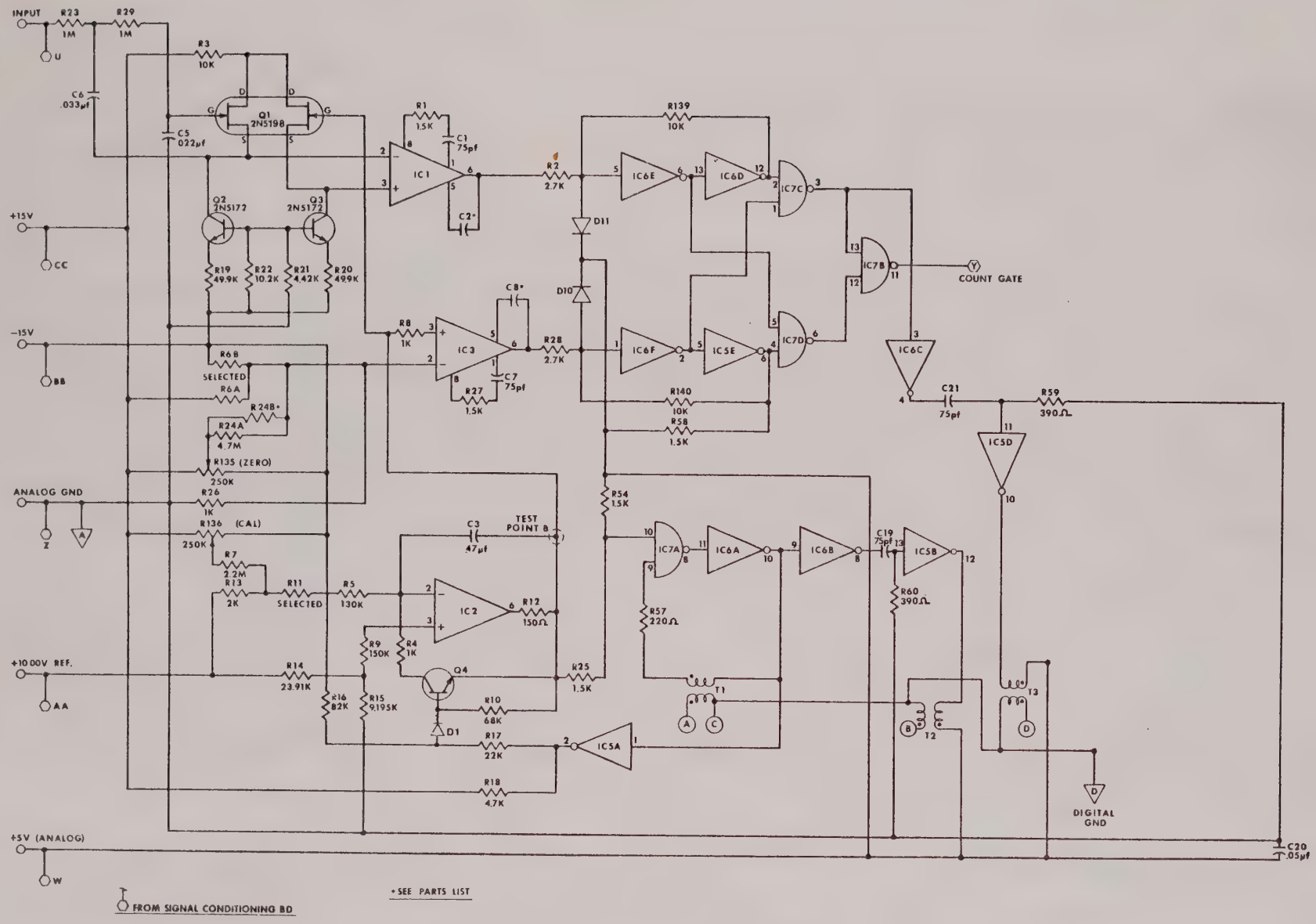
Instrument Model Number
Instrument Serial Number
Part Reference Designator
Part Description
Part Stock Number

The following information is to be used for setting end points only. For calibration standards see the charts in section 7.2.

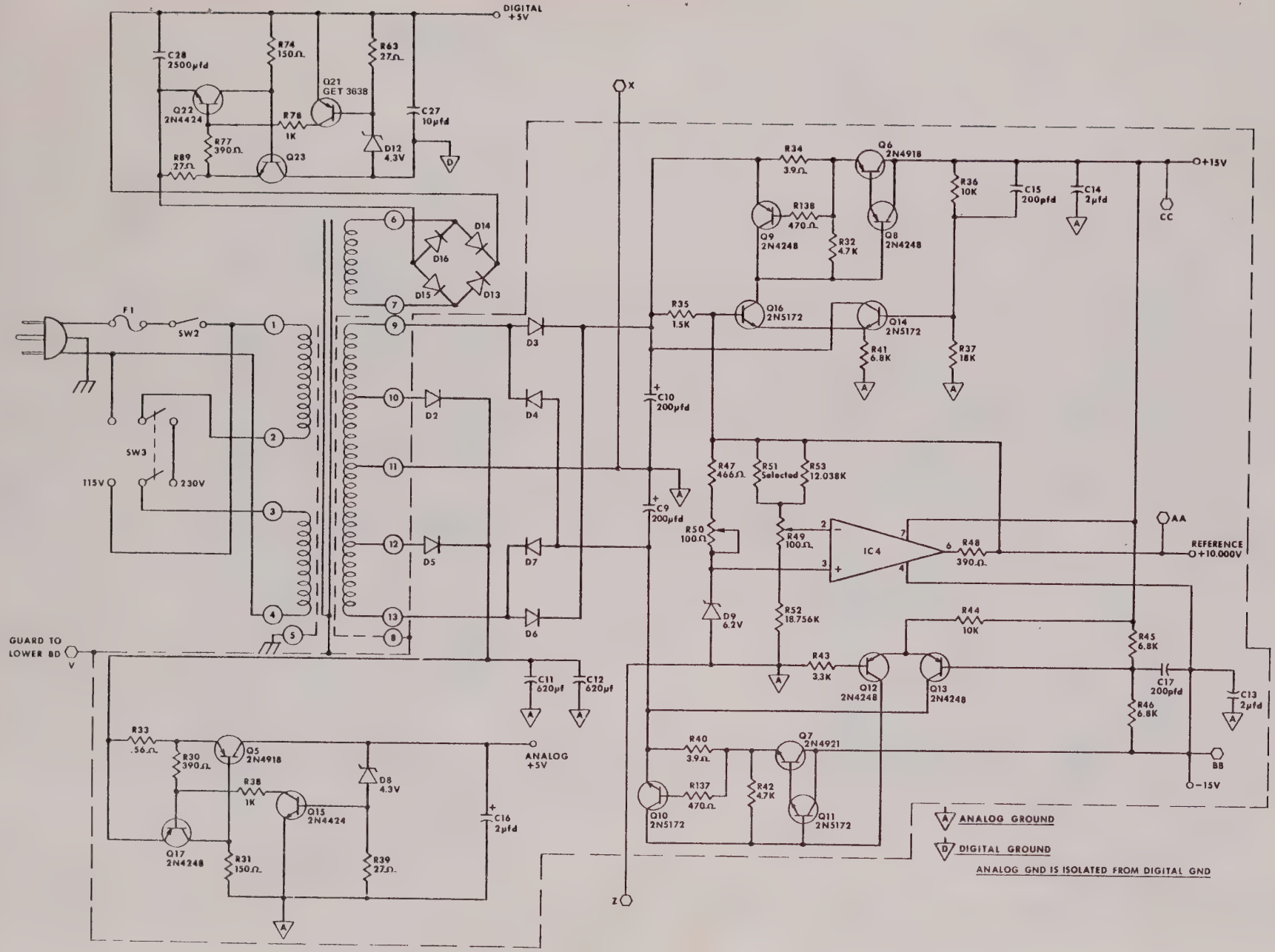
TYPE	590JC	590JF	590KC	590KF	590RC	590RF	590SC	590SF	590TC	590TF
Milivolts	42.961	42.956	55.891	54.908	18.728	19.397	16.717	18.591	20.880	20.797
Digital Reading	760.2	1400.0	1400.0	2500	1600	3000	1600	3200	400.0	750.0



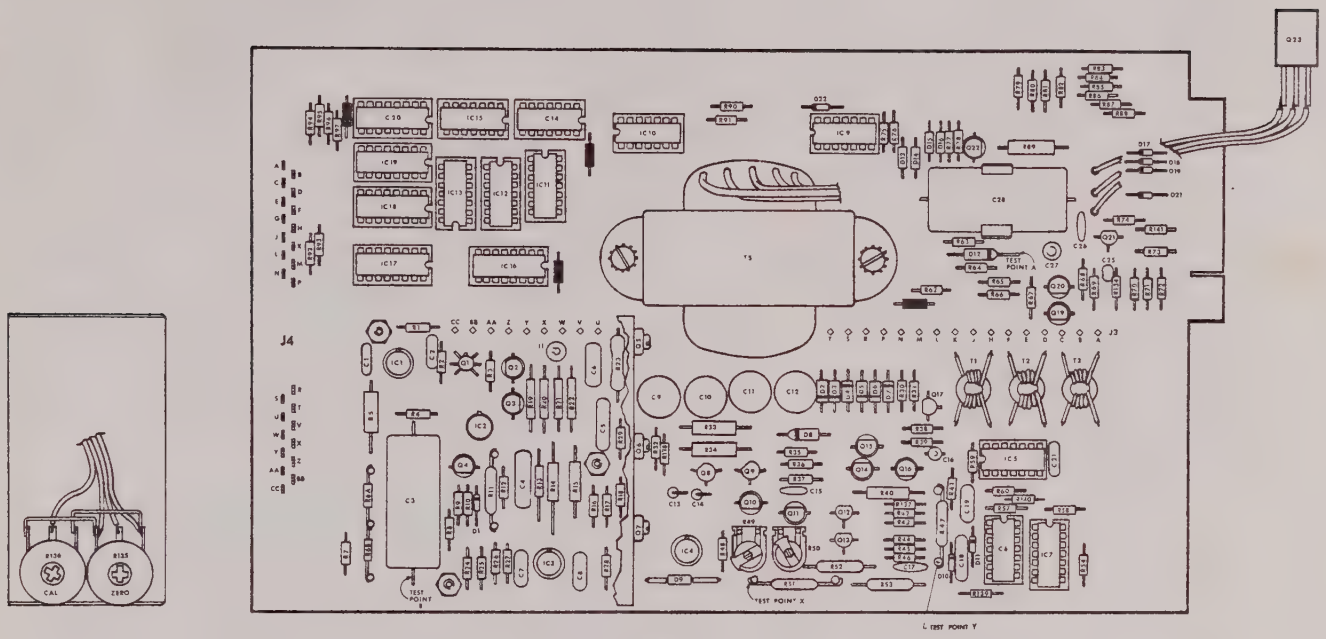
Schematic of Digital Section (A to D Board)
Figure 5



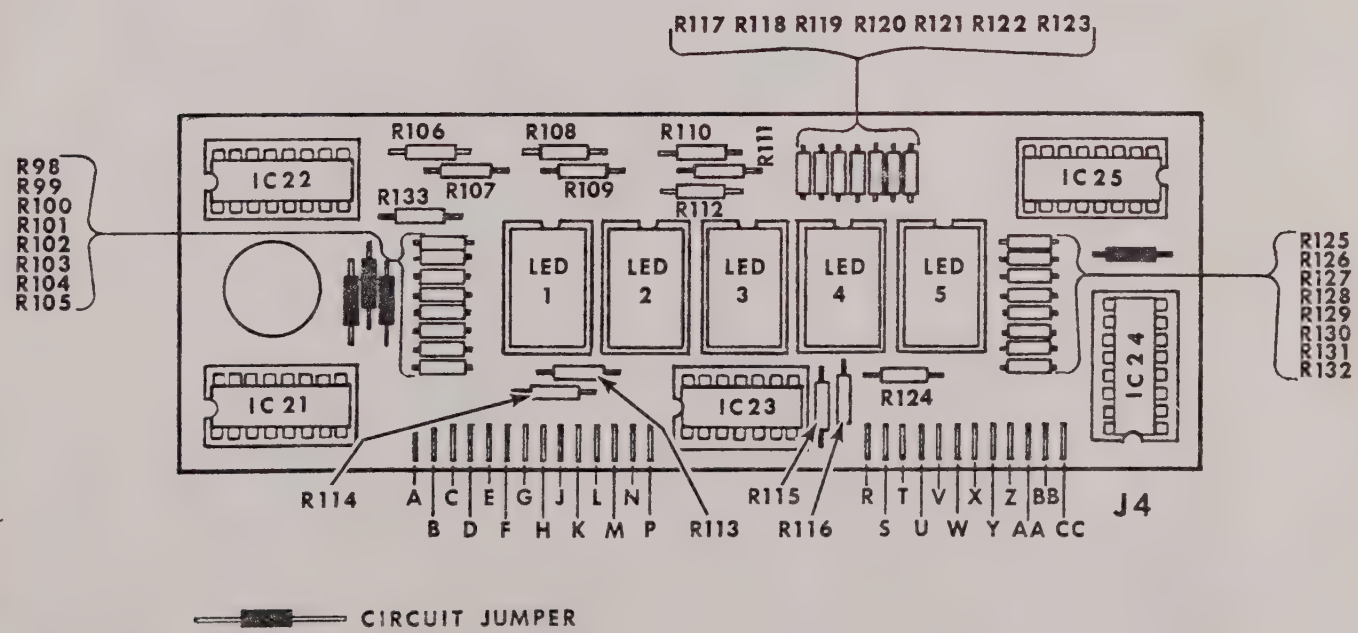
Schematic of Analog Section (A to D Board)
Figure 6



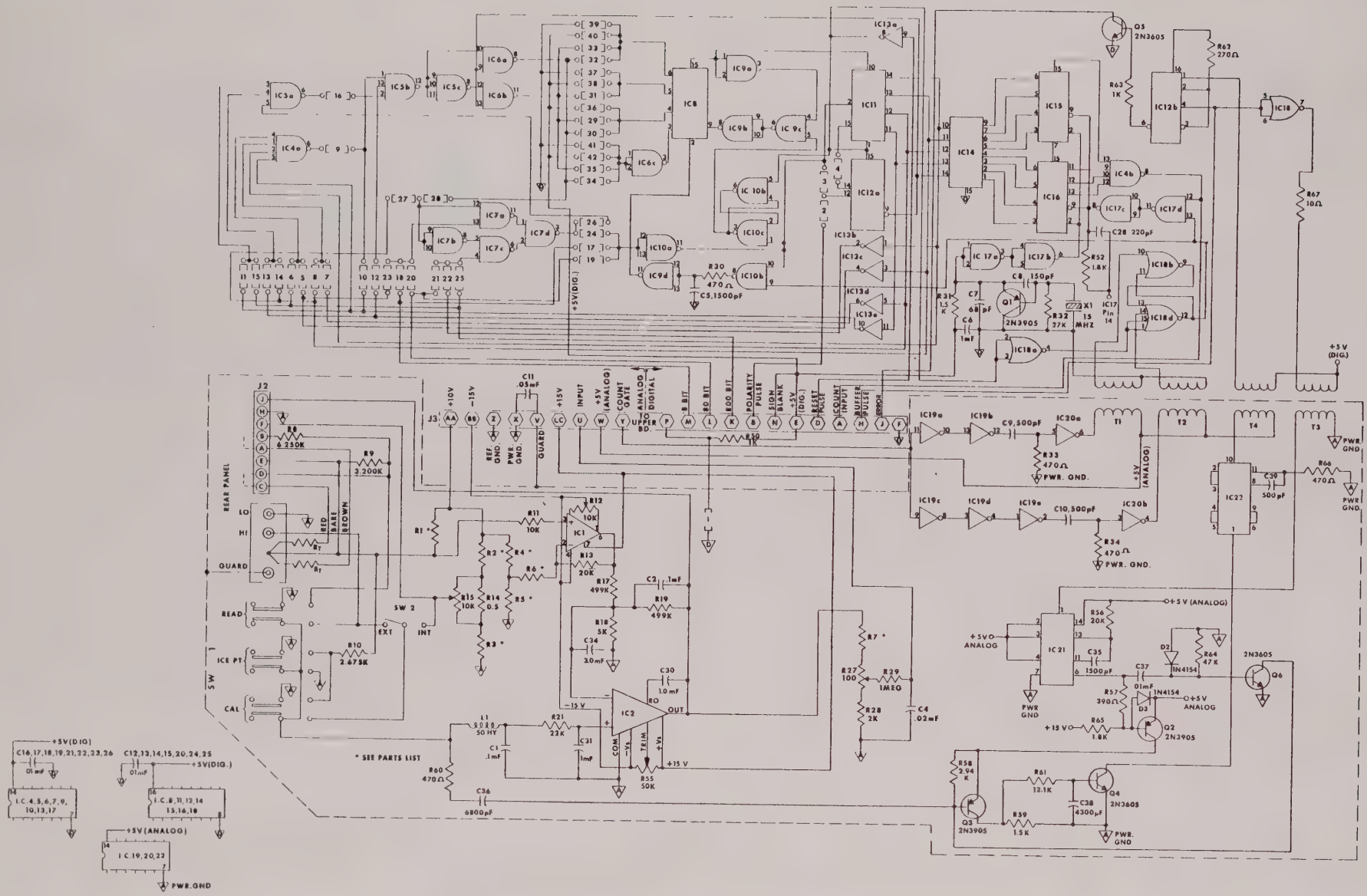
Schematic of Power Supply (A to D Board)
Figure 7



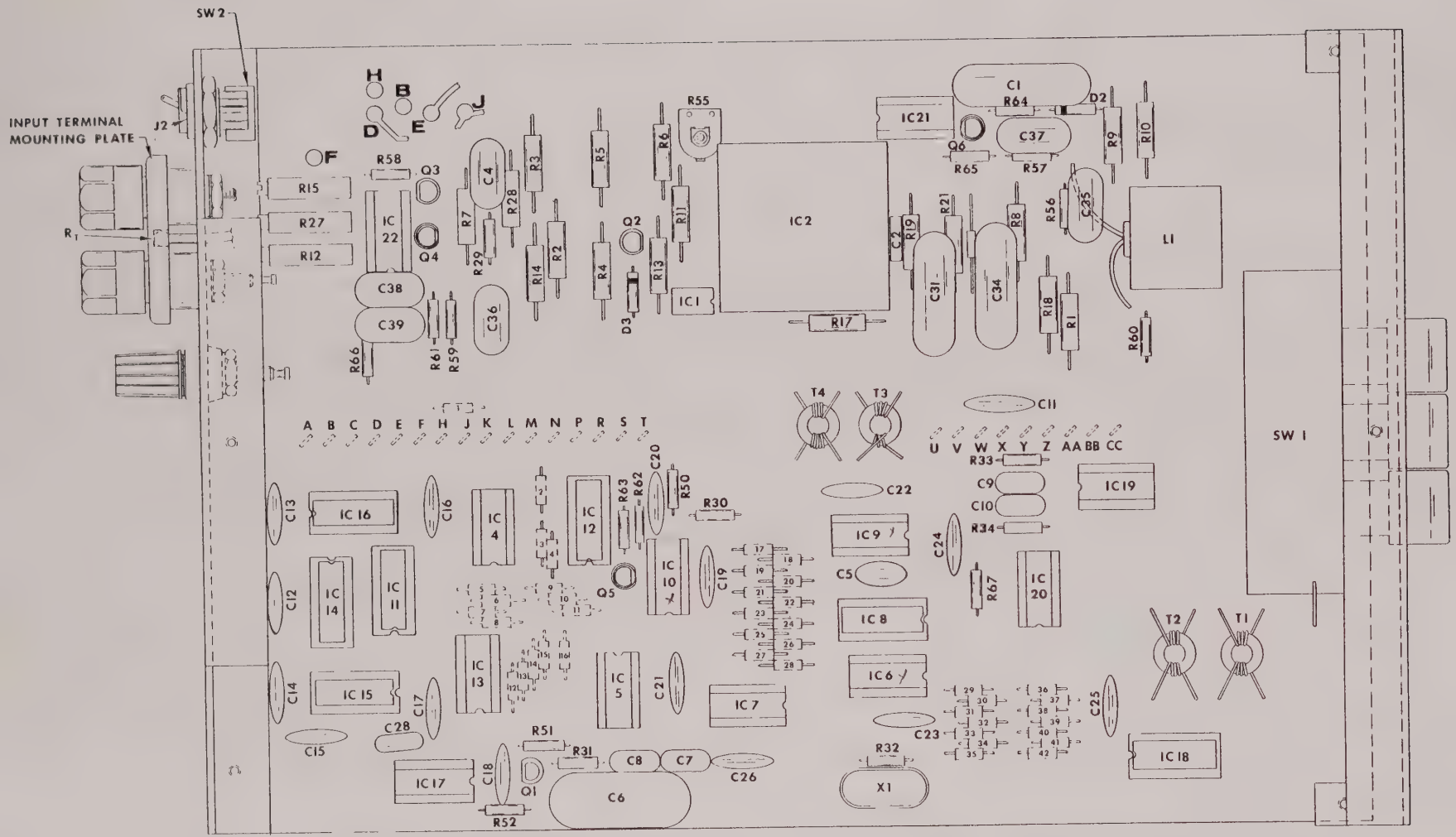
Pictorial of Analog to Digital Conversion Board
Figure 8



Pictorial of Readout Board
Figure 9

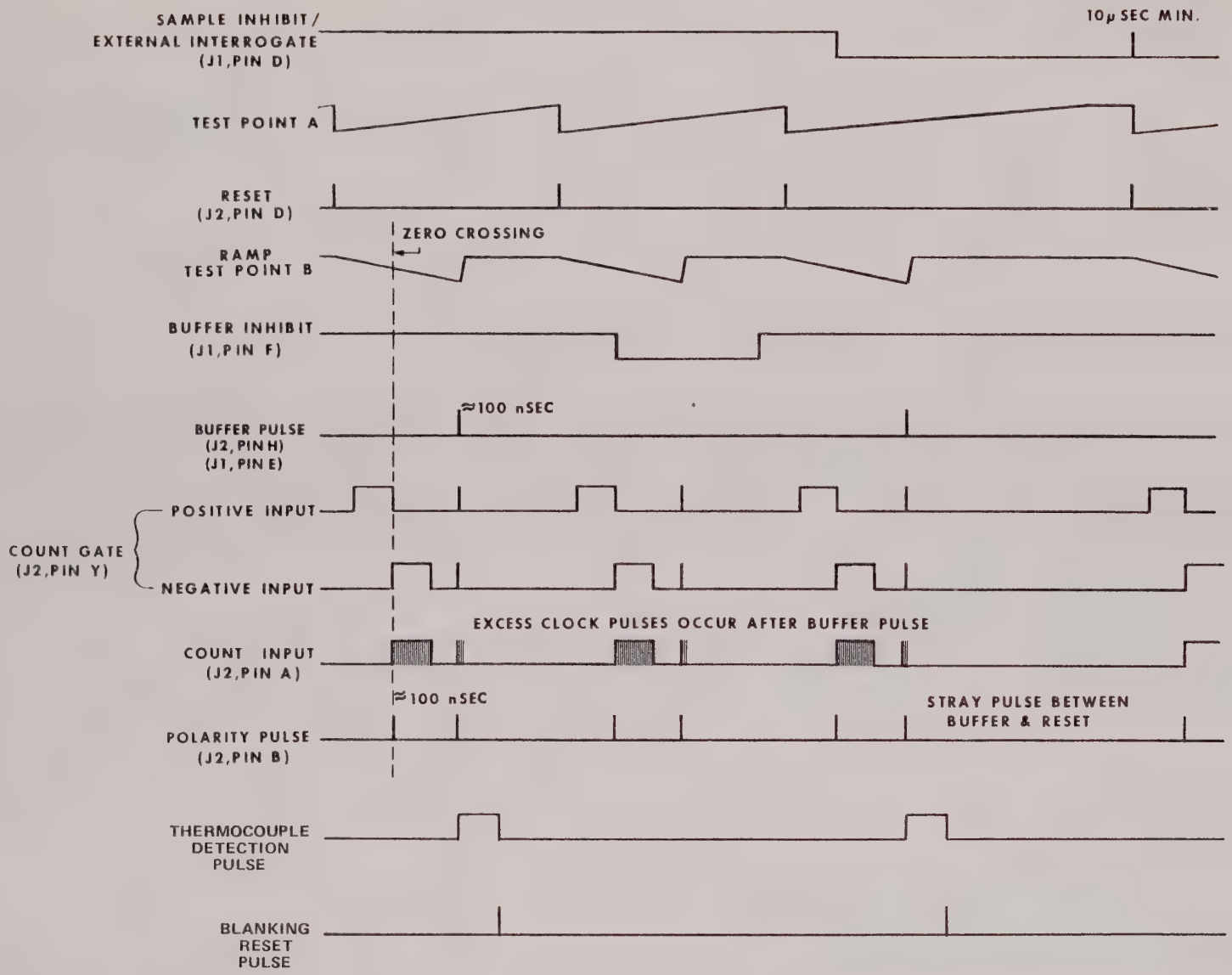


Schematic of Signal Conditioning Board
Figure 10



JUMPERS: 6–16 JUMPERS WILL BE USED ACCORDING TO MODEL NUMBER

Pictorial of Signal Conditioning Board
Figure 11



COUNT BITS ARE TTL POSITIVE TRUE, DYNAMIC ERROR BIT IS TTL, NEGATIVE TRUE AT J2
POSITIVE TRUE AT J1

< 2000 IS POSITIVE TTL WHEN READING IS < 2000 (NEG. > 2000)

< 2000 AND ERROR ARE STORED DATA AND UPDATED WITH EACH BUFFER PULSE.

TTL: 1=+2.2 VOLTS 0=+0.5 VOLTS

Analog to Digital Board Timing
Figure 12

PARTS LIST
SIGNAL CONDITIONING BOARD

Ref. Des.	Description	Stock Number
C1	Capacitor, mylar, 0.1μf @ 600VDC	56-10205CYC104K6
C2	Capacitor, mylar, 0.1μf @ 200VDC	56-10205BYB104J2
C4	Capacitor, mylar, .02μf @ 400VDC	56-10205BYB203J4
C5	Capacitor, mylar, .0068μf @ 600V	56-10205AYA682J6
C6, 30, 31	Capacitor, mylar, 1.0μf @ 100V	56-10206CYC105J1
C7	Capacitor, mica, 68pf @ 500V	56-10210A680HL5
C8	Capacitor, mica, 150pf @ 500V	56-10210A151HL5
C9, 10	Capacitor, mica 500pfd @ 500V	56-10210A501HL5
C11	Capacitor, Ceramic .05μf @ 600V	56-10215H503KT6
C12-20, 22-25	Capacitor, Ceramic .01μf @ 500V	56-10215C103KTR5
C21, 26 (C21 used on Type TC, JC, JF, KF)		
C21, 26 (26 used on Type JF, JC, KF)	Capacitor, Ceramic .01μf @ 500V	56-10215C103KTR5
C28	Capacitor, mica, 220pf @ 500V	56-10210A221FL5
C34	Capacitor, mylar, 3μf @ 100V	56-10206CYC305J1
C35	Capacitor, mica, 1500pf @ 500V	56-10210B152FL5
C36	Capacitor, mylar, 6800pf @ 400V	56-10205AYA682H4
C37	Capacitor, mylar, .01μf @ 400V	56-10205AYA103J4
C38	Capacitor, mica, 4300pf @ 500V	56-10210C432FL5
C39	Capacitor, mica 1000pf @ 500V	56-10210B102JP5
D2, 3	Diode, Signal 1N4154	40-09297
IC1	Integrated circuit Amplifier Fairchild μA741	40-12440
IC2	Integrated circuit, Chopper Stabilized amplifier, non-inverting	40-12809
IC4	Integrated circuit, dual 4 input NAND Gate fairchild 9004	40-12447
IC5 (used on type JF, KF, TC, JC only)	Integrated circuit triple 3 input NAND Gate Fairchild 9003	40-12448
IC6, 9, 10, 17	Integrated circuit quad 2-input NAND Gate Fairchild 9002	40-12449
IC7 (used on type JC, JF, KF only)	Integrated circuit quad 2 input NAND Gate Fairchild 9002	40-12449
IC8, 11, 15, 16	Integrated circuit, Binary counter Fairchild 9316	40-12367
IC12	Integrated circuit, Dual J-K Flip-flop Fairchild 9024	40-12442
IC13, 19, 22	Integrated circuit Hex inverter Fairchild 9016	40-12444
IC14	Integrated circuit, read only memory	
590JC	Read only memory	
590JF	Read only memory	40-12771
590KC	Read only memory	40-12774
590KF	Read only memory	40-12775
590RC	Read only memory	40-12878
590RF	Read only memory	40-12879
590SC	Read only memory	40-12876
590SF	Read only memory	40-12877
590TC	Read only memory	40-12772
590TF	Read only memory	40-12773
IC18	Integrated circuit, quad NOR Gate Fairchild 9015	40-12445
IC20	Integrated circuit, Hex inverter-open collector Fairchild 9017	40-12443

Ref. Des.	Description	Stock Number
IC21	Integrated circuit monostable multvibrator Fairchild 9601	40-12734
L1 (all T and J Models)	Inductor Assembly, 50HY	42-13926
L1 (all other Models)	Inductor Assembly (factory selected)	
Q1, 2, 3	Transistor, Motorola 2N3905	40-09537
Q4, 5, 6	Transistor, switching G.E. 2N3605A	40-09354
R1 (590JF)	Resistor, metal, film, 60.3K, 0.1%, ½W	55-10111BGK060R3
(590KC)	79K, 0.1%, ½W	55-10111BGK079
(590RC)	565K, 0.1%, ½W	55-10111BGK565
(590SC)	565K, 0.1%, ½W	55-10111BGK565
(590TC)	77.7K, 0.1%,½W	55-10111BGK077R7
(590KF)	79K, 0.1%, ½W	55-10111BGK079
(590RF)	565K, 0.1%, ½W	55-10111BGK565
(590SF)	565K, 0.1%, ½W	55-10111BGK565
(590TF)	77.7K, 0.1%, ½W	55-10111BGK077R7
(590JC)	60.3K, 0.1%, ½W	55-10111BGK060R3
R2 (590JC)	Resistor, wire wound, 17.931K, 0.05%, 1W	55-10121ADK017R931
(590JF)	30.868K, 0.05%, 5W	55-10123ADK030R868
(590KC)	31.834K, 0.01%, 5W	55-10123VDK031R834
(590KF)	5.868K, 0.05%, 1W	55-10121ADK005R868
(590RC)	8.085K, 0.05%, 1W	55-10121ADK008R085
(590RF)	14.573K, 0.05%, 1W	55-10121ADK014R573
(590SC)	9.285K, 0.05%, 1W	55-10121ADK009R285
(590SF)	15.774K, 0.05%, 1W	55-10121ADK015R774
(590TC)	17.964, 0.05%, 1W	55-10121ADK017R964
(590TF)	33.937, 0.05%, 5W	55-10123ADK033R937
R3 (590JC)	Resistor, wire wound, 68.97Ω, 0.05%, 1W	55-10121ADA068R97
(590JF)	131.7Ω, 0.05%, 1W	55-10121ADA131R7
(590KC)	166.46Ω, 0.01%, 1W	55-10121VDA166R46
(590KF)	32.03Ω, 0.05%, 1W	55-10121ADA032R03
(590RC)	14.8Ω, 0.05%, 1W	55-10121ADA014R8
(590RF)	26.83Ω, 0.05%, 1W	55-10121ADA026R83
(590SC)	15.17Ω, 0.05%, 1W	55-10121ADA015R17
(590SF)	25.92Ω, 0.05%, 1W	55-10121ADA025R92
(590TC)	36.08Ω, 0.05%, 1W	55-10121ADA036R08
(590TF)	63.4Ω, 0.05%, 1W	55-10121ADA063R4
R4 (590JC)	Resistor, metal film, 56.76K, 0.1%, ½W	55-10111BGK056R76
(590JF)	51.47K, 0.1%, ½W	55-10111BGK051R47
(590KC)	73.87K, 0.1%, ½W	55-10111BGK073R87
(590KF)	67.03K, 0.1%, ½W	55-10111BGK067R03
(590RC)	101K, 0.1%, ½W	55-10111BGK101
(590RF)	91.91K, 0.1%, ½W	55-10111BGK091R91
(590SC)	101K, 0.1%, ½W	55-10111BGK101
(590SF)	91.91K, 0.1%, ½W	55-10111BGK091R91
(590TC)	72.75K, 0.1%, ½W	55-10111BGK072R75
(590TF)	66.12K, 0.1%, ½W	55-10111BGK066R12
R5 (590JC)	Resistor, wire wound, 5.483K, 0.1%, 1W	55-10121BFK005R483
(590JF)	5.538K, 0.1%, 1W	55-10121BFK005R538
(590KC)	5.363K, 0.1%, 1W	55-10121BFK005R363
(590KF)	5.403K, 0.1%, 1W	55-10121BFK005R403
(590RC)	1.01K, 0.1%, 1W	55-10121BFK001R01
(590RF)	1.01K, 0.1%, 1W	55-10121BFK001R01
(590SC)	1.01K, 0.1%, 1W	55-10121BFK001R01
(590SF)	1.011K, 0.1%, 1W	55-10121BFK001R011
(590TC)	5.369, 0.1%, 1W	55-10121BFK005R369
(590TF)	5.409, 0.1%, 1W	55-10121BFK005R409
R6 (590JC)	Resistor, wire wound, 15K, .05%, 1W	55-10121ADK015
(590JF)	15K, .05%, 1W	55-10121ADK015
(590KC)	15K, .05%, 1W	55-10121ADK015
(590KF)	15K, .05%, 1W	55-10121ADK015

Ref. Des.	Description	Stock Number
(590RC)	19K, .01%, 1W	55-10121BDK019
(590RF)	19K, .01%, 1W	55-10121BDK019
(590SC)	19K, .01%, 1W	55-10121BDK019
(590SF)	19K, .01%, 1W	55-10121BDK019
(590TC)	15K, .05%, 1W	55-10121ADK015
(590TF)	15K, .05%, 1W	55-10121ADK015
R7 (590JC)	Resistor, wire wound, 2.441K, .01%, 1W	55-10121BDK002R441
(590JF)	2.441K, .01%, 1W	55-10121BDK002R441
(590KC)	3.571K, .01%, 1W	55-10121BDK003R571
(590KF)	3.571K, .01%, 1W	55-10121BDK003R571
R8	Resistor, wire wound, 625Ω 0.1%, 1W	55-10121BDK006R25
R9	Resistor, wire wound, 3200Ω 0.1%, 1W	55-10121BDK003R2
R10	Resistor, wire wound, 2765Ω 1W	55-10121BDK002R765
R11, R20	Resistor, metal film 10K, 1%, ½W	55-10111EJK010
R12, 15	Resistor, variable, 10K	41-11611-10
R13	Resistor, wire wound, 20K, 0.1%, 1W	55-10121BDK020
R14	Resistor, wire wound, 0.5Ω 1%, 1W	55-10121EFA000R5
R17, 19	Resistor, metal film, 499K, 0.1%, ½W	55-10111BGK499
R18	Resistor, wire wound, 5K, 0.1%, 1W	55-10121BDK005
R21	Resistor, Carbon, 22K, 10%, ¼W	55-10101JK022
R27	Resistor, variable 100Ω	41-11611-04
R28	Resistor, wire wound, 2K, 0.1%, 1W	55-10121BDK002
R29	Resistor, carbon, 1 meg, 10%, ¼W	55-10101JM001
R30	Resistor, carbon, 100Ω 10%, ¼W	55-10101JA100
R31, 59	Resistor, carbon, 1.5K, 10%, ¼W	55-10101JK001R5
R32	Resistor, carbon, 27K, 10%, ¼W	55-10101JK027
R33, 34	Resistor, carbon, 470Ω, 10%, ¼W	55-10101JA470
R50, 63	Resistor, carbon, 1K, 10%, ¼W	55-10101JK001
R51	Zero ohm jumper pin	50-07657
R52, 65	Resistor, carbon, 1.8K, 10%, ¼W	55-10101JK001R8
R55	Resistor, variable, 50K	55-12388KK050
R56	Resistor, metal film, 20K, 1%, 1/8W	55-10169ELK020
R57	Resistor, carbon, 390Ω, 10%, ¼W	55-10101JA390
R58	Resistor, metal film, 2.94K, 1%, 1/8W	55-10169ELK002R94
R60	Resistor, carbon, 470Ω, 10%, ¼W	55-10101JA470
R61	Resistor, metal film, 12.1K, 1%, 1/8W	55-10169ELK012R1
R62, 66	Resistor, carbon 270Ω 10%, ¼W	55-10101JA270
R64	Resistor, carbon, 47K, 10%, ¼W	55-10101JK047
R67	Resistor, carbon, 10Ω 10%, ¼W	55-10101JA010
RT	Thermistor, YSI #44018	40-12455
SW1	Switch, function	43-12397
	Button, red	43-11098-02
	Button, black	43-11098-04
	Button, gray	43-11098-06
SW2	Switch, slide, internal/external	43-12456
SW3	Switch, 115V/230V	43-12375
SW4	Switch, power	43-12376
T1, 2, 3, 4	Transformer pulse	42-09598
X1	Crystal, 15MHz	40-12390
	HARDWARE	
	Binding post, white	50-07196-04
	Connector, male, 9 pin	51-09610-03
	Connector, female, 9 pin	51-09609-03
	Fuse, ¼A, 3AG, Slo Blo	52-09309-02
	Fuse, holder	50-12865
	Knob, Ice Point Ancal.	50-12933
	Terminals, input assembly	50-12563
	Circuit jumper	50-07657

PARTS LIST
ANALOG TO DIGITAL CONVERSION BOARD

Ref. Des.	Description	Stock Number
C1, 7, 19, 21	Capacitor, Mica, 75pF @ 500VDC	56-10210A750JP5
C2, C8	Capacitor, mica, selected	
C3	Capacitor, Polystyrene, 0.47μF @ 100VDC	56-10208EY474FL1
C4	Capacitor, Mylar, 0.22μF @ 100VDC	56-10206AYA224J1
C5	Capacitor, Mylar, 0.022μF @ 400VDC	56-10206AYA223H4
C6	Capacitor, Mylar, 0.033μF @ 400VDC	56-10206AYA333H4
C9, 10	Capacitor, Electrolytic, 200μF @ 35VDC	56-10216BG207N35
C11, 12	Capacitor, Electrolytic, 620μF @ 10VDC	56-10216BH27N10
C13, 14, 16	Capacitor, Tantalum, 2μF @ 35VDC	56-10222B205N35
C15, 17	Capacitor, Ceramic, 200pF @ 1000VDC	56-10215A201KT10
C18	Capacitor, Ceramic, 0.05μF @ 500VDC	56-10215C503KTR5
C25	Capacitor, Tantalum, 1μF @ 35VDC	56-10222A105N35
C27	Capacitor, Tantalum, 10μF @ 15VDC	56-10222C106N15
C28	Capacitor, Electrolytic, 2500μF @ 15VDC	56-12396EW258M15
D2, 3, 4, 5, 6, 7, 13, 14, 15, 16	Diode, power, 0.8A @ 100PIV	40-07787-01
D8, 12	Diode, Zener, 4.3V ± 10%, 240mA	40-09219-08
D9	Diode, Zener, 6.2V, 1N827A	40-12364
D10, 11, 17, 18, 19, 21, 22	Diode, 1N4154	40-09297
IC1, 3	Integrated circuit, Operational amplifier Motorola MC1709CG	40-09280
IC2, 4	Integrated circuit, Operational amplifier Fairchild 741C	40-12484
IC5, 23	Integrated circuit, Hex inverter, Fairchild 7405	40-12371
IC6, 9	Integrated circuit, Hex inverter, Texas Instrument SN7404	40-12222
IC7, 10	Integrated circuit, Quad two input gate Fairchild 7400	40-12368
IC11, 12, 13, 14, 15	Integrated circuit, Decade counter, Fairchild 7490	40-12369
IC16, 17, 18, 19, 20	Integrated circuit, Quad latch, Fairchild 7475	40-12370
IC21, 22, 24, 25	Integrated circuit, 7 bar decoder, Fairchild 7447	40-12372
LED1	Light emitting diode readout	40-12373
LED2, 3, 4, 5	Light emitting diode readout	40-12219
Q1	Transistor, 2N5198	40-12930
Q2, 3, 10, 11, 14, 16, 19	Transistor, 2N5172	40-11353
Q4	Transistor, special	40-11041
Q5, 6	Transistor, 2N4918	40-11358
Q7	Transistor, 2N4921	40-12366
Q8, 9, 12, 13, 17	Transistor, 2N4248	40-09437
Q15	Transistor, 2N5172	40-11353
Q20	Transistor, 2N6027	40-09834
Q21	Transistor, GET 3638	40-13114
Q22	Transistor, 2N4424	40-11439
Q23	Transistor, Motorola MJE3055	40-12560

Ref. Des.	Description	Stock Number
R1, 25, 27, 35, 54, 58, 65, 67, 68, 73, 91	Resistor, 1.5K, 10%, 1/4W	55-10101JK001R5
R2, 28	Resistor, Carbon, 2.7K, 10%, 1/4W	55-10101JK002R7
R3, 36, 44	Resistor, Carbon, 10K, 10%, 1/4W	55-10101HK010
R4, 8, 26	Resistor, Carbon, 1K, 10%, 1/4W	55-10101JK001
R5	Resistor, Wire, 147.92K, 0.1%, 1/3W	55-12387BWK147R092
R6a, 6b	Resistor, Selected	
R7	Resistor, Carbon, 2.2 meg, 5%, 1/4W	55-10101HM002R2
R9	Resistor, Carbon, 150K, 10%, 1/4W	55-10101JK150
R10, 66	Resistor, Carbon, 68K, 10%, 1/4W	55-10101JK068
R11	Resistor, selected	
R12, 31, 74, 99-115, 117-123, 126-133	Resistor, Carbon, 150Ω, 10%, 1/4W	55-10101JA150
R13	Resistor, Wire, 2K, 1%, 1/4W	55-10164ELK002
R14	Resistor, Wire, 23.91K, 0.1%, 2W	55-10122BDK023R91
R15	Resistor, Wire, 9.195K, 0.1%, 1W	55-10121BDK009R195
R16	Resistor, Carbon, 82K, 10%, 1/4W	55-10101JK082
R17	Resistor, Carbon, 22K, 10%, 1/4W	55-10101JK022
R18, 32, 42, 134	Resistor, Carbon, 4.7K, 10%, 1/4W	55-10101JK004R7
R19, 20	Resistor, Wire, 49.9K, 1%, 1/4W	55-10164ELK049R9
R21	Resistor, Wire, 4.42K,1%, 1/4W	55-10164ELK004R42
R22	Resistor, Wire, 10.2K, 1%, 1/4W	55-10164ELK010R2
R23	Resistor, Tin oxide, 1 meg, 1%, 1W	55-12394FM001
R24a (R24b on Models R, S, T only)	Resistor, Carbon, 4.7 meg, 10%, 1/4W	55-10101JM004R7
R29	Resistor, Carbon, 1 meg, 10%, 1/4W	55-10101JM001
R30, 48, 59, 60, 77	Resistor Carbon, 390Ω, 10%, 1/4W	55-10101JA390
R33	Resistor, Wire, 0.56Ω, 10%, 2W	55-10124JA000R56
R34, 40	Resistor, Wire, 3.9Ω, 10%, 2W	55-10124JA003R9
R37	Resistor, Carbon, 18K, 5%, 1/4W	55-10101HK018
R38, 62, 70, 71, 72, 75, 76, 79, 80-88 90, 92-97	Resistor, Carbon, 100Ω, 10%, 1/4W	55-10101JA100
R39, 63	Resistor, Carbon, 27Ω, 10%, 1/4W	55-10101JA027
R41, 45, 46	Resistor, Carbon, 6.8K, 5%, 1/4W	55-10101HK006R8
R43, 64	Resistor, Carbon, 3.3K, 10%, 1/4W	55-10101JK003R3
R47	Resistor, Wire, 466Ω, 1%, 1W	55-10121EDA466
R49, 50	Resistor, variable, cermat, 100Ω, 20%	55-12388KA100
R51	Resistor, selected	
R52	Resistor, Wire, 18.756K, 0.1%, 1W	55-10121BDK018R756
R53	Resistor, Wire, 12.038K, 0.1%, 1W	55-10121BDK012R038
R57	Resistor, Carbon, 220Ω, 10%, 1/4W	55-10101JA220
R62, 70, 71, 72, 75, 76, 79, 80-88 90, 92-97	Resistor, Carbon, 100Ω, 10%, 1/4W	55-10101JA100
R69	Resistor, Carbon, 33Ω, 10%, 1/4W	55-10101JA033
R78	Resistor, carbon, 100Ω, 10%, 1/4W	55-10101JA100
R89	Resistor, Wire, 0.27Ω, 10%, 2W	55-10124JA00R27
R98, 116, 124, 125, 137, 138	Resistor, Carbon, 470Ω, 10%, 1/4W	55-10101JA470
R135, 136	Resistor, variable, wire, 20K, 20%, 2W	55-12395KK020
T1	Transformer, power	42-12347
T2, 3, 5	Transformer, pulse	42-09598

9. USE OF THE 590 IN A MODEL 1590 DATALOGGER

In a Model 1590 Datalogger, the 590 A to D board and the readout board are used without the 590 instrument case. (See Figure 20 of Datalogger instruction manual for location). There are some special connections which must be made to operate a 1590 Datalogger. These connections have to do with the thermistor which furnishes ice point compensation for the instrument.

9.1 Thermistor Connections for a Standard 20 Channel 1590

In order for the 590 to operate properly with the 20 Channel Datalogger, there must be no pins jumpered on the thermistor input plug (See Figure 14). This activates the thermistor mounted on the Datalogger input board. This compensates for the thermocouple voltage that results from the dissimilar metals of the thermocouple leads and the terminals of the input board.

9.2 Connections for an Expanded (up to 200 Channel) 1590

9.2.1 Thermistor Connections

Model 1590 Dataloggers which require more than 20 input points use an auxiliary Model 637 Scanner Slave. Thus the connections for ice point compensation are altered. There are two distinct methods of ice point compensation for these models. In either method the leads from the imput board thermistor should be disconnected.

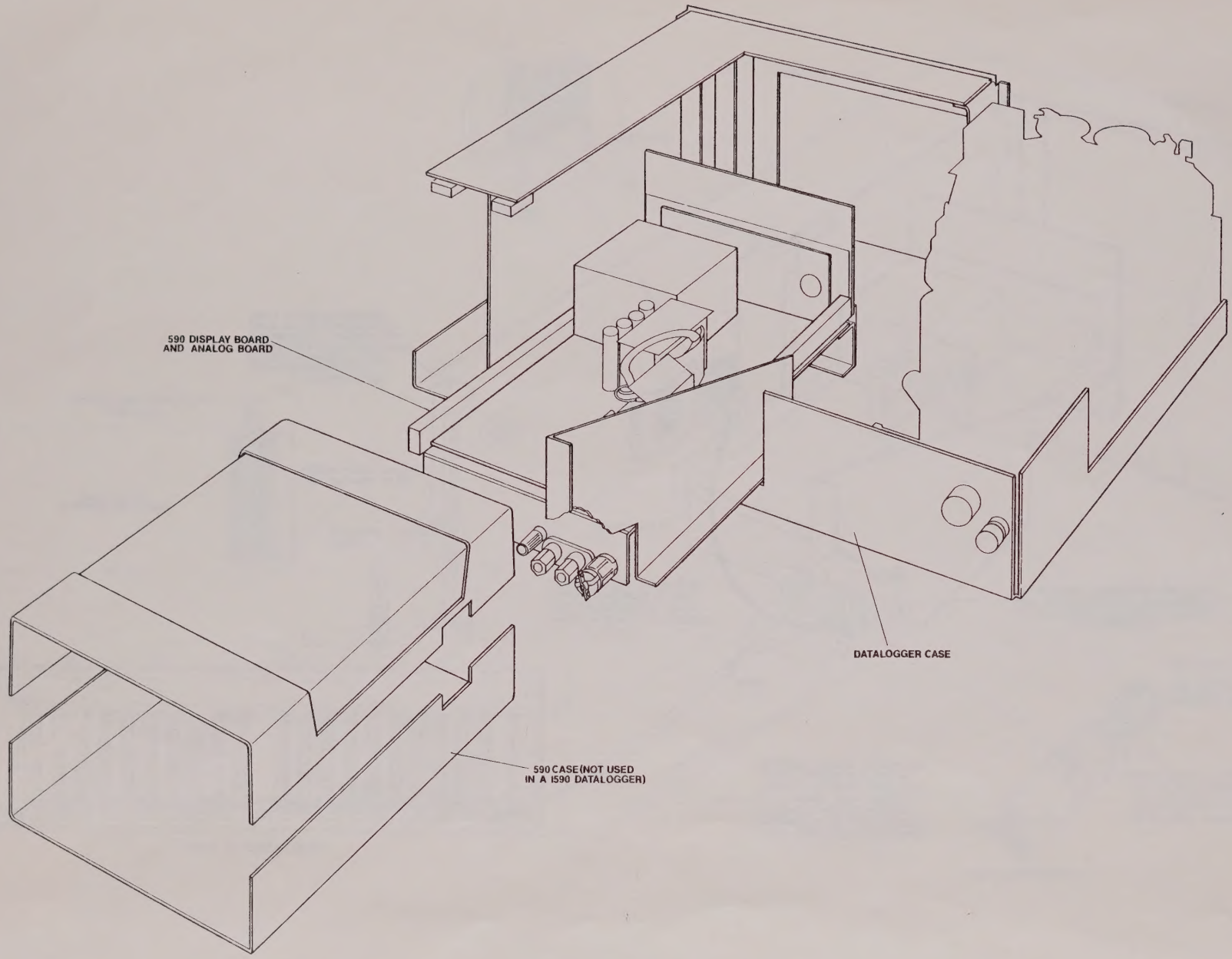
The first method uses a thermistor which is internal to the 590 Module and requires two jumpers on the thermistor input plug (See Figure 14).

These connections activate a thermistor which is mounted at the 590 input terminals. This compensates for the voltage generated when thermocouple leads are attached to the metal terminals. When connected in this manner, the leads from the Scanner Slave to the 590 MUST BE THERMOCOUPLE WIRE. If copper wire is used, another thermocouple voltage will be generated which is uncompensated.

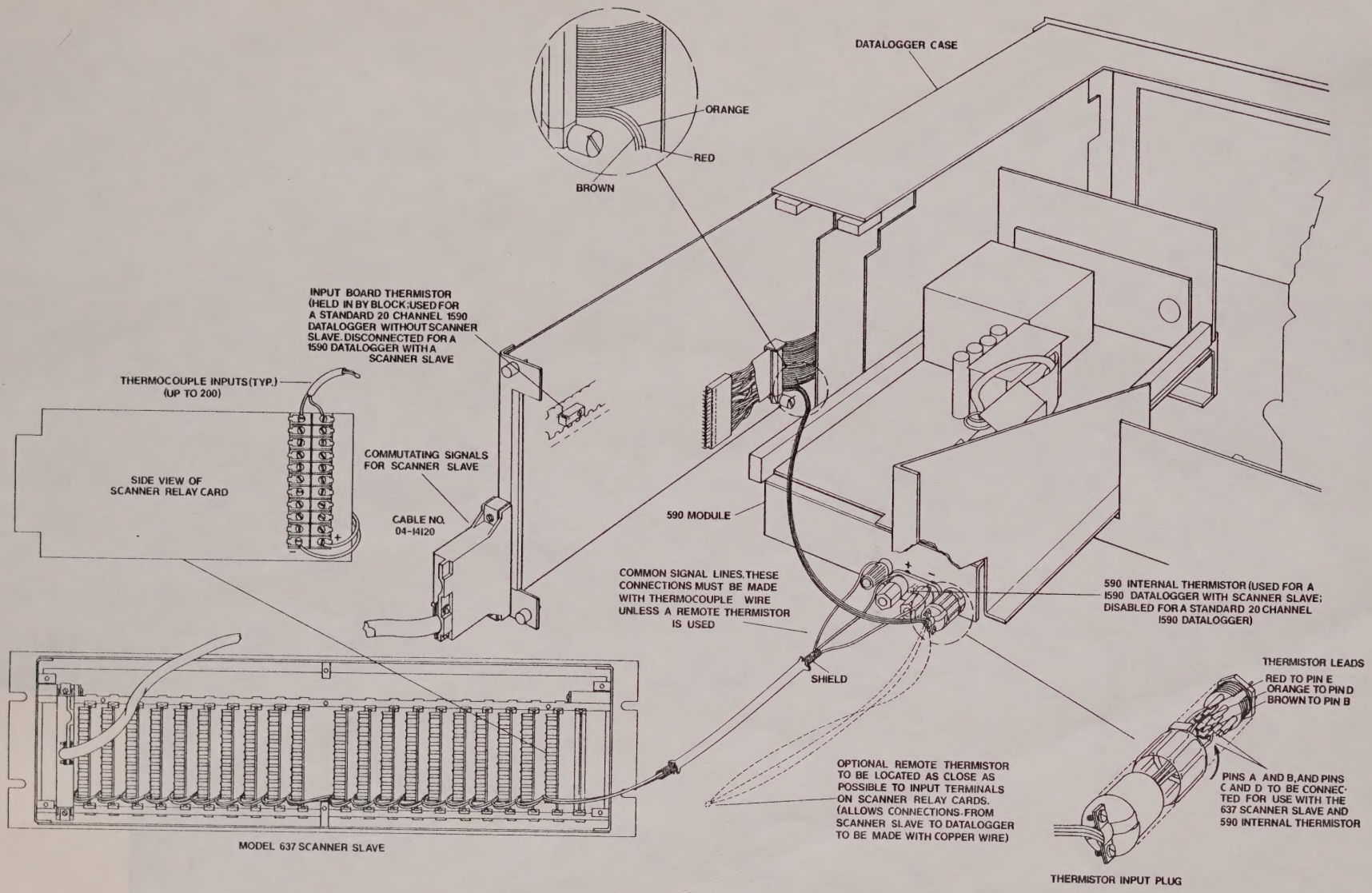
If it is desired to use copper wire to connect between the Datalogger and Scanner Slave, it is necessary to use a thermistor mounted as close as possible to the terminal blocks of the Scanner Slave Relay Cards. Either the back panel of the Slave or the retention bar which holds the cards in place is an acceptable location. The Scanner Slave thermistor leads must then be connected to the thermistor input plug. For information as to connections for the thermistor leads, see Section 3.4 of this manual. There should be no jumpers on the thermistor input plug for this type of ice point compensation.

9.2.2 Data Source Connections

The leads from each thermocouple are connected to the terminals of a 635-3 Relay Card (See Figure 4A of Datalogger manual). The common terminals of each Relay Card must then be connected together and connected to the input terminals at the rear of the 590. (See Figure 14 of this manual).



Makeup of a 1590 Datalogger
Figure 13


DATALOGGER CASE
ORANGE
RED
BROWN
INPUT BOARD THERMISTOR (HELD IN BY BLOCK; USED FOR A STANDARD 20 CHANNEL 1590 DATALOGGER WITHOUT SCANNER SLAVE. DISCONNECTED FOR A 1590 DATALOGGER WITH A SCANNER SLAVE
THERMOCOUPLE INPUTS (TYP.) (UP TO 200)
SIDE VIEW OF SCANNER RELAY CARD
COMMUTATING SIGNALS FOR SCANNER SLAVE
CABLE NO. 04-14120
590 MODULE
COMMON SIGNAL LINES. THESE CONNECTIONS MUST BE MADE WITH THERMOCOUPLE WIRE UNLESS A REMOTE THERMISTOR IS USED
590 INTERNAL THERMISTOR (USED FOR A 1590 DATALOGGER WITH SCANNER SLAVE; DISABLED FOR A STANDARD 20 CHANNEL 1590 DATALOGGER)
SHIELD
THERMISTOR LEADS
RED TO PIN E
ORANGE TO PIN D
BROWN TO PIN B
PINS A AND B, AND PINS C AND D TO BE CONNECTED FOR USE WITH THE 637 SCANNER SLAVE AND 590 INTERNAL THERMISTOR
OPTIONAL REMOTE THERMISTOR TO BE LOCATED AS CLOSE AS POSSIBLE TO INPUT TERMINALS ON SCANNER RELAY CARDS. (ALLOWS CONNECTIONS FROM SCANNER SLAVE TO DATALOGGER TO BE MADE WITH COPPER WIRE)
MODEL 637 SCANNER SLAVE
THERMISTOR INPUT PLUG

Ice Point and Expander Connections for a 1590 Datalogger
Figure 14

MP MASTER
MA26227